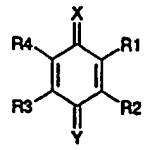
Method of doping organic semiconductors with quinonediimine derivatives

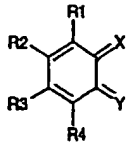
Claims

1. Use of an organic mesomeric compound as organic dopant for doping an organic semiconducting matrix material for varying the electrical properties thereof, characterized in that the mesomeric compound is a quinone or quinone derivative or a 1,3,2-dioxaborine or a 1,3,2-dioxaborine derivative and in that the mesomeric compound, under like evaporation conditions, has a lower volatility than tetrafluorotetracyano-quinonedimethane (F4TCNQ).

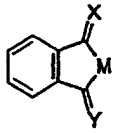
2. Use of a compound according to Claim 1, characterized in that the mesomeric quinoid compound has the general



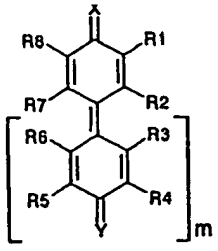
Formula I or



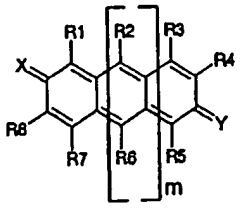
Formula II or



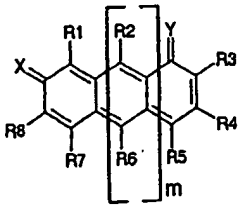
Formula III or



Formula IV or



Formula V or

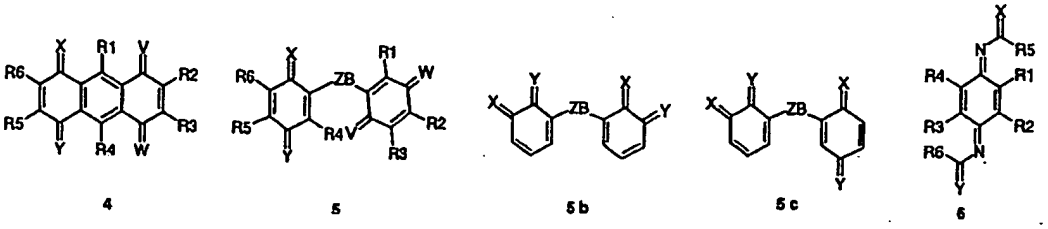


Formula VI

with m = 1, 2, 3, 4 for formula IV and

with m = 0, 1, 2, 3, 4 for formula V or VI

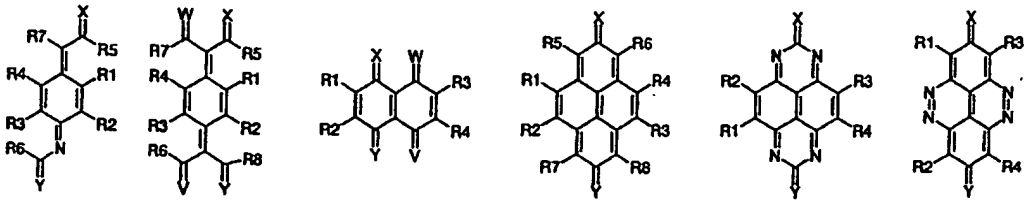
or



4 5 5b 5c 6

Formula VII or Formula VIII or Formula IX or Formula X or Formula XI

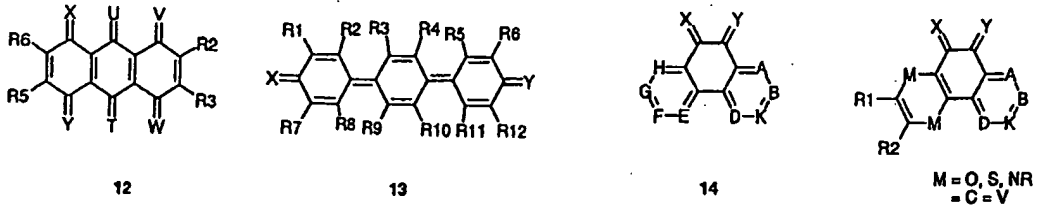
or



7 8 9 10 11 11a

Formula XII or Formula XIII or Formula XIV or Formula XV or Formula XVI or Formula XVII

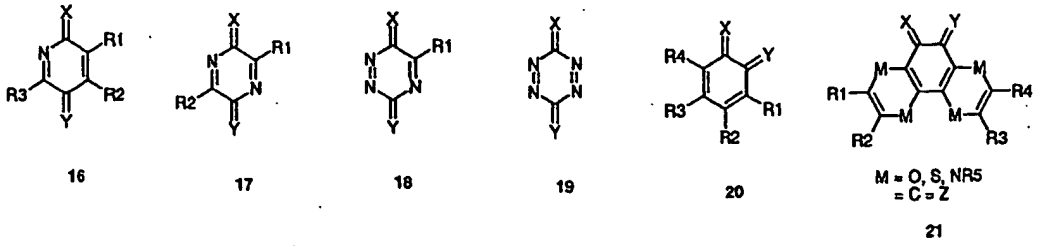
or



12 13 14 M = O, S, NR = C = V 15

Formula XVIII or Formula XIX or Formula XX or Formula XXI

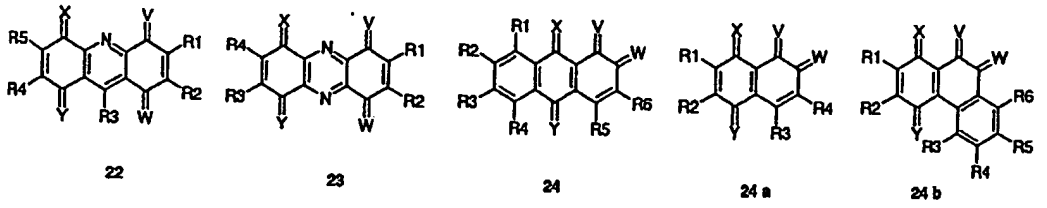
or



16 17 18 19 20 21

Formula XXII or Formula XXIII or Formula XXIV or Formula XXV or Formula XXVI or Formula XXVII

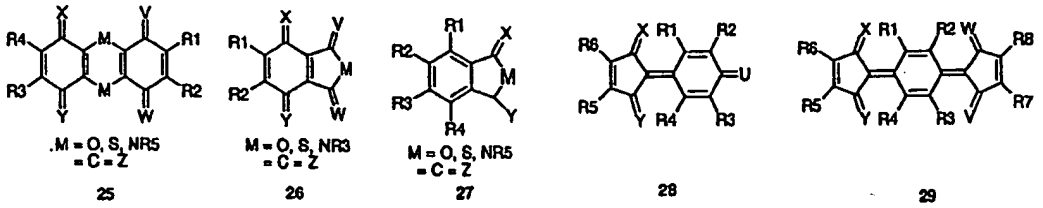
or



22 23 24 24 a 24 b

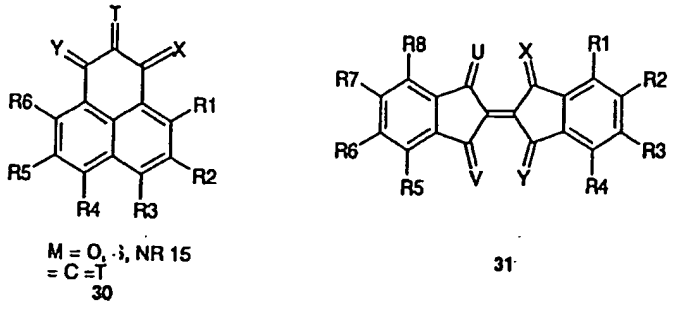
Formula XXVIII or Formula XXIX or Formula XXX or Formula XXXI or Formula XXXII

or



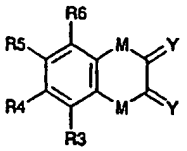
25 26 27 28 29

Formula XXXIII or Formula XXXIV or Formula XXXV or Formula XXXVI or Formula XXXVII



30 31

or Formula XXXVIII or Formula XXXIX



M = -O-, -S-, -NR-
= C = Z

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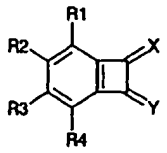


33

or Formula XXXX or Formula XXXXI,

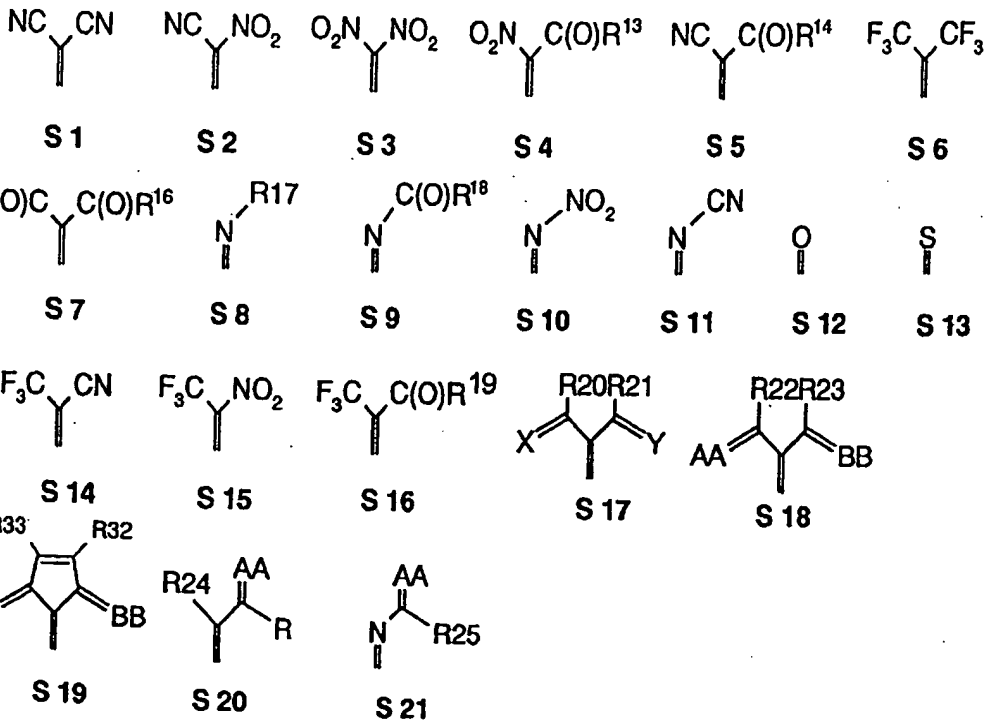
where the quinoid aromatic ring may be substituted or unsubstituted (R = H) or may be anellated with at least one aromatic ring, where -M- is a bivalent atom or a group with a bivalent bridge atom and where = T, = U, = V, = X, = Y or = Z are double bond-bonded atoms or groups of atoms with mesomerically and/or inductively attracting residues, and where ZB is a divalent atom or a divalent polyatomic bridge.

3. Use of a compound according to Claim 2, characterized in that the symbols have the following meanings:

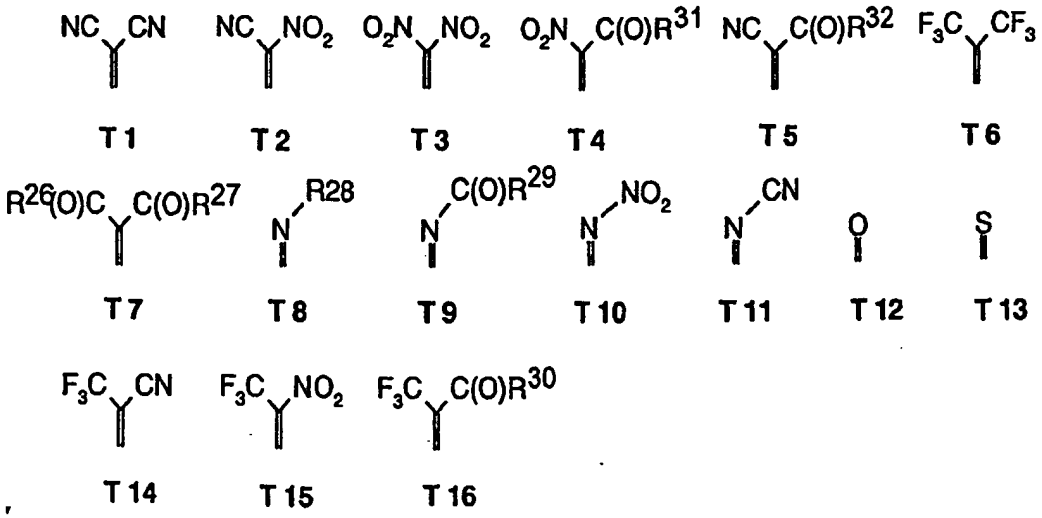
-M- is –O-, -S-, -NR- or –C(= Z)-, preferably –O-, -S- or –NR- or preferably –C(= Z)-,

and

= T, = U, = V, = W, =X, = Y or = Z are alike or unlike and are selected from the group consisting of



where the substituent AA is selected from the group consisting of

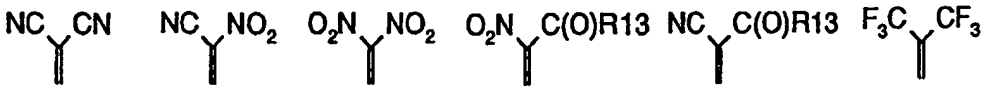


where AA may form a multiple-membered ring with another residue R of the compound,

where Z in the formulas VIII; IX or X represents a direct bond, or a monoatomic or polyatomic group, which may be saturated or unsaturated, and

where A, B, D, E, F, G, H, K in the formulas XX and XXI are alike or unlike and are selected from the group = N-, = P-, or = CR-, where R may represent a hydrogen atom or a residue.

4. Use of a compound according to Claim 3, characterized in that the substituents T, U. V, W, X, Y and Z are alike or unlike and are selected from the group consisting of



S 1

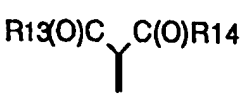
S 2

S 3

S 4

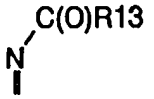
S 5

S 6

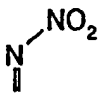


S 7

S 8



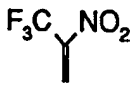
S 9



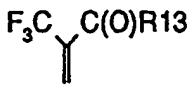
S 10

S 11

S 14



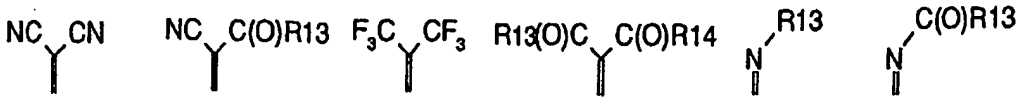
S 15



S 16

where R is an organic residue or hydrogen.

5. Use of a compound according to Claim 3, characterized in that the substituents T, U, V, W, X, Y and Z are alike or unlike and are selected from the group consisting of

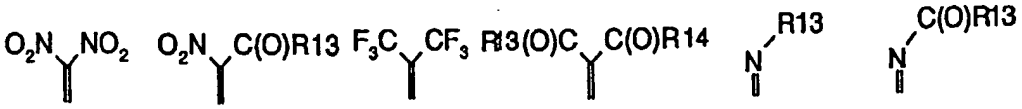


S 1 S 5 S 6 S 7 S 8 S 9

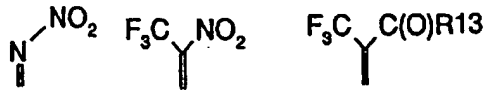
S 10 S 11 S 12 S 13 S 14 S 16

where R is an organic residue or hydrogen.

6. Use of a compound according to Claim 3, characterized in that the residues T, U, V, W, X, Y and Z are alike or unlike and are selected from the group consisting of



S 3 S 4 S 6 S 7 S 8 S 9



S 10 S 15 S 16

where R is an organic residue or hydrogen, while R13 of the group S8 may be an organic residue, hydrogen or CF_3.

7. Use of a compound according to any of Claims 1 to 6, characterized in that the compound represents a quinone or quinone derivative with at least two non-anellated quinoid systems, which are linked together directly or by a bridge - ZB - with 1 to 10 bridge atoms, which are carbon atoms or heteroatoms or carbon atoms and heteroatoms.

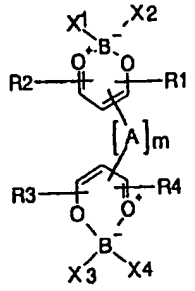
8. Use of a compound according to any of Claims 1 to 7, characterized in that the compound 2, 3, 4, 5 or 6 has quinoid ring systems with 5 or 6 carbon atoms in each instance, which may be at least partially replaced by heteroatoms.

9. Use of a compound according to Claim 8, characterized in that at least 2, more or all of the quinoid ring systems with mesomeric linkage to a larger quinoid system are anellated or linked together mesomerically by an unsaturated bridge.

10. Use of a compound according to Claim 1, characterized in that the compound 1, 2, 3, 4, 5 or 6 contains 1,3,2-dioxaborine rings.

11. Use of a compound according to Claim 10, characterized in that at least 2, more or all of the 1,3,2-dioxaborine rings with mesomeric and/or aromatic linkage are, optionally via additional aromatic rings, anellated or linked together mesomerically by an unsaturated bridge.

12. Use of a compound according to Claim 1, characterized in that the mesomeric 1,3,2-dioxaborine compound has the general formula L



Formula L

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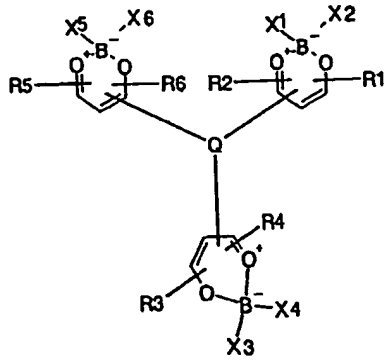
where A is a bivalent residue, which may have one or more carbon atoms, which may be partially or completely replaced by heteroatoms,

where m = 0 or is a whole number greater than 0, and

where X is a monodentate ligand, where two ligands X may form a bidentate ligand,

or in that the mesomeric 1,3,2-dioxaborine compound has the general formula LI

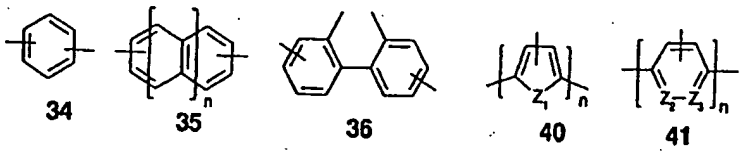


33 Formula LI

where Q is a trivalent residue and

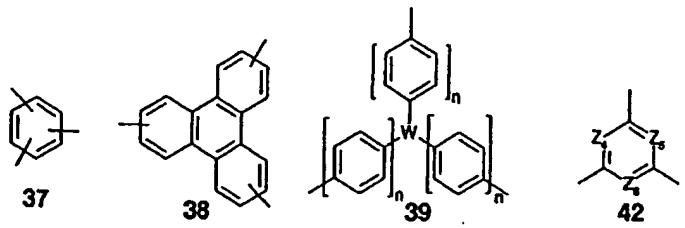
where X is a monodentate ligand, where two ligands X may form a bidentate ligand.

13. Use of a compound according to Claim 12, characterized in that A is selected from the group consisting of



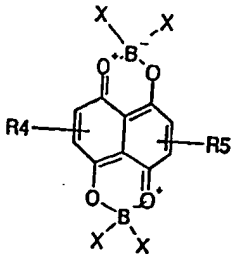
and –(C(R1) = C(R2)-) n with n equal to 1, 2, 3, 4, 5 or 6 and –NR1-, where Z_1, Z_2 and Z_3 are bivalent or trivalent atoms, and where one or both residues R1, R2 may form a ring with one or both adjacent 1,3,2-dioxaborine rings.

14. Use of a compound according to Claim 12, characterized in that Q is selected from the group consisting of



nitrogen, N(aryl)3, where aryl comprises heteroaryl, phosphorus and P(aryl)3, where aryl comprises heteroaryl, where Z^4, Z^5 and Z^6 are trivalent atoms, and where W is a trivalent atom or a group of trivalent atoms, while n may be equal to 0, 1, 2, 3 or 4.

15. Use of a compound according to Claim12, characterized in that the mesomeric 1,3,2-dioxaborine compound has the general formula LII



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Formula LII

where X is a monodentate ligand, where two ligands X may form a bidentate ligand and where R4, R5 are organic residues which may have 1,3,2-dioxaborine rings.

16. Use of a compound according to any of Claims 1 to 15, characterized in that the compound 1, 2, 3, 4, 5 or 6 has 6 aryl residues, which in each instance are anellated with one another or with one or more quinoid systems or with one or more 1,3,2-dioxaborine rings of the compound.

17. Use of a compound according to any of Claims 1 to 16, characterized in that the compound is one of the following compounds: N,N'-dicyana-2,3,5,6-tetrafluoro-1,4-quinonediimine, N,N'-dicyano-2,5-dichloro-1,4-quinonediimine, N,N'-dicyano-2,5-dichloro-3,6-difluoro-1,4-quinonediimine, N,N'-dicyano-2,3,5,6,7,8-hexafluoro-1,4-naphthoquinonediimine, 1,4,5,8-tetrahydro-1,4,5,8-tetrathia-2,3,6,7-tetracyanoanthraquinine and/or

2,2,7,7-tetrafluoro-2,7-dihydro-1,3,6,8-doxa-2,7-diborapentachloro-benzo[e]pyrene.

18. Use of a compound according to any of Claims 1 to 17, characterized in that the matrix material is hole-conducting.

19. Use of a compound according to any of Claims 1 to 18, characterized in that the matrix material consists partially or completely of a metal phthalocyanine complex, a porphyrin complex, an oligothiophene compound, an oligophenyl compound, an oligophenylenevinylene compound, an oligofluorene compound, a pentacene compound, a compound with a triarylamine unit and/or a spiro-bifluorene compound.

20. Use of a compound according to any of Claims 1 to 19, characterized in that the molar doping ratio of dopant to matrix molecule and monomeric unit of a polymeric matrix molecule is between 1:1 and 1:10,000.

21. Organic semiconducting material containing an organic matrix molecule and an organic dopant, characterized in that the dopant is one or more compounds according to any of Claims 1 to 19.

22. Organic semiconducting material according to Claim 21, characterized in that the molar doping ratio of dopant to matrix molecule and monomeric unit of a polymer matrix molecule is between 1:1 and 1:10,000.

23. Method of preparing an organic semiconducting material containing an organic matrix molecule and an organic dopant according to Claim 21 or 22, characterized in that the dopant is evaporated from a precursor compound which upon heating and/or irradiation releases the dopant.

24. Electronic component having an organic semiconducting material, which is doped with an organic dopant for varying the electronic properties of the semiconducting matrix material, where doping has taken place with use of at least one or more of the compounds according to any of Claims 1 to 20.

25. Electronic component according to Claim 24 in the form of an organic light-emitting diode (OLED), a photovoltaic cell, an organic solar cell, an organic diode or an organic field-effect transistor.